The Network Information Management System (NIMS) in the Deep Space Network

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In an effort to better manage enormous amounts of administrative, engineering, and management data that is distributed worldwide, a study was conducted which identified the need for a network support system. The Network Information Management System (NIMS) will provide the Deep Space Network with the tools to provide an easily accessible source of valid information to support management activities and provide a more cost-effective method of acquiring, maintaining, and retrieving data.

I. Introduction

The NIMS (Network Information Management System) will reside on a Tandem computer system and is being designed to provide distributed administrative data processing. The NIMS will perform the following major functions in the Deep Space Network (DSN): data acquisition, data management, and data distribution.

For several years the DSN has been using computers in a variety of ways to assist in the administrative, engineering and management tasks of keeping the DSN functioning successfully. These various computer applications have evolved sporadically, individually justified on their own merits and with varying degrees of success. They have been implemented on a variety of computers, ranging from the Institutional Computer at JPL through various minicomputers to some recent microprocessor-based systems such as the Automated Office Data Center (AODC).

Although most of the individual efforts have been successful, lack of coordination has contributed to the following state of affairs:

(1) Duplication and inconsistency of data among files.

(2) Inaccessibility of files to those not expert in data processing languages.

(3) Obsolete or inaccurate data.

(4) Inability to move data from one facility to another.

(5) Denial of several applications because they were not individually cost justified.

The Configuration Control and Audit (CCA) project, established in the early 1970s, provided much documentation and groundwork relating to the NIMS project. The CCA project identified the needs for a network support subsystem, provided the basic tradeoff studies, and conducted a demonstration which showed the validity of the concept (Ref. 1).

A recent study, under the NIMS project, was conducted which consisted of a users survey and an analysis of current needs of the DSN. The study primarily focused on Goldstone Operations (378), Operations Sustaining Engineering (377), and Control Center Operations (371), with a cursory study of Engineering Sections 331, 333, 338, 355, and 430. The Deep Space Stations in Spain and Australia were presented a model of the Goldstone survey for any relevant updates and comments.

The objectives of the NIMS efforts evolved in response to the needs identified from the above study and are outlined below:

(1) Provide an easily accessible source of valid information to support DSN management activities.

(2) Provide a more cost-effective method of acquiring, maintaining, and retrieving data.

II. NIMS Key Characteristics

The NIMS is being designed as a general-purpose computer utility that can be adapted to future needs by specific user application programs. Each of these application programs can exist independently or in concert with one another on the system. Computer tools and services will be provided by vendor-supplied software to support applications programmers, data base administrators, and casual users.

Based primarily on user analysis, the NIMS will feature the following characteristics:

Distributed Processing System. Computational resources are distributed across the network thus reducing communications costs and providing local control and responsibility for the data. This eliminates complete dependence upon a central computer, which can be catastrophic when communication links are down.

Networking Software. Networking features such as remote logon, file access, use of peripherals and services, and message routing through the network are essential to the NIMS distributed environment. Packet switching technology will be used to accomplish the task.

Modularity. The ability to add applications, nodes, terminals, and communications facilities over time are vital to the NIMS success. The ability to connect to existing DSN computer hardware for message and data transfer will be supported.

Utilization of Existing DSN Facilities, Computers, and Services. Consideration is given to existing DSN facilities in supporting NIMS implementation. Existing DSN communication facilities will be used to interconnect NIMS modes. Protocol to interface DSN mini- and microcomputers as well as Telemail and TWX services will be provided.

Database Management System (DBMS). The ability to logically address data, define data dictionaries, and describe "user views" are important capabilities for the system to possess. Because the DSN has many complex data relationships, a network model DBMS is the most satisfactory to implement.

File Management. Key, random, and sequential access methods will be supported.

Programming Tools. BASIC, FORTRAN, and COBOL will be provided for application program development. These languages should interface to the NIMS DBMS and file management system where data generated by them should be compatible between them. A system programming language should be available as well as tools for defining screen formats and menus.

System Performance. Operator response will be between 2-5 seconds, with no response delay greater than 20 seconds. Benchmark analysis will be performed during the vendor evaluation process.

Transaction Processing. The NIMS will support both batch and interactive processing.

Security. The NIMS operating software will provide entry and password access to files and databases to guard against accidental or malicious access to data and application programs. Network security provisions will also be supported.

On-Line Support Facilities. The NIMS will provide facilities that aid in the operation of the NIMS itself, management and maintenance of the database, and implementation of new features. Means are provided for operator visibility into the communications and system status. Diagnostic programs will be available to isolate failing elements.

Availability. As a distributed system, failures will tend to be localized so remaining nodes still function unless requiring data from the failed node. The Tandem Non-Stop II design maximizes individual node availability. The NIMS networking applications depend upon the availability of the NASA Communications (NASCOM) circuit to establish the communications link. These factors make the total availability parameter more difficult to define.

Reliability. Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR) parameters were criteria applied in the vendor selection process. A MTBF of 750 hours for NIMS node operations is needed for operational satisfaction. The MTTR for a node must be less than 4 hours.

System Integrity. The NIMS, its DBMS and support utilities will provide the means to back up the database and protect it in the event of catastrophic failures and restore it to a previous known state.

III. NIMS Configuration

Several different configurations were studied for the NIMS. Because the NIMS is intended to be a computer-based information management system, the studies were carried out in the two general areas of hardware and database management software. The resulting configuration is discussed below.

A. Hardware

The current administrative data communications arrangements between the complexes depend on a single NASA Communications (NASCOM) circuit. The NIMS application study has shown the need for many diverse activities to be supported. Time-sharing the single line will not provide the required support capability of NIMS nor is it the most cost-effective method of accomplishing NIMS tasks. Accordingly the NIMS has been designed as a distributed data processing system, thereby alleviating the communications circuit time-share problem.

The NIMS is comprised of four nodes. These four nodes are located at the three Deep Space Communication Complexes (DSCCs) and Pasadena. Each of these nodes has one or more terminals connected to it. The Pasadena node will serve as the communications node interconnecting the three regular nodes.

B. Software

The heart of the NIMS system is the software that performs the function of database management. These software packages are commonly referred to as Data Base Management Systems (DBMS). A network model DBMS which directly shows actual relationships and correlations that exist between the data would be the best model to use for DSN data. A relational model DBMS would be the next best choice. Tandem supplies a hybrid relational DBMS that incorporates some of the features of a network model.

This DBMS will perform data and message definitions, terminal and transaction control, data base consistency, enquiry and reporting, and data base maintenance.

Other vendor-supplied off-the-shelf software will provide utilities to monitor the network environment, manipulate files and peripherals, create text and source code, monitor and report individual node statistics, and perform system diagnostic checks.

C. Vendor Selection

Data General, Digital Equipment Corporation, Hewlett-Packard, Prime and Tandem Computer were asked to participate in a competitive evaluation conducted by JPL. Evaluation was conducted in the areas of hardware, software, communications characteristics, reliability, maintainability and contractor support. The Tandem Nonstop II architecture was chosen as best suited to the NIMS project requirements.

IV. First NIMS Application

The Engineering Change Management (ECM) data base is an administrative tool to support management of the engineering change process in the DSN. An upgrade is currently in development (Phase II) to eliminate perceived major shortcomings of the existing ECM Phase I system. Problems of inflexible report writing programs, lack of visibility into details of assessment phase, awkward and inflexible file structure and inability to communicate with other data bases, thus requiring duplicate entries when updating milestones, are to be solved in ECM Phase II. This upgrade will be the first application implemented on the NIMS.

The ECM environment is a distributed one in which portions of the ECM database are placed at the nodes that are using the data. The ECM database is the sum of the individual pieces in the NIMS nodes supporting that application.

Phase II ECM implementation calls initially for a single NIMS node to be installed in the ECM office. Approximately six months after hardware installation ECM Phase II will provide the following services to ECM users: flexible, user-defined reporting system, independence from the Univac 1100/81F, paperless operation, visibility of the assessment process, menu-driven interface for updates and user-friendly operation. ECM Phase II will be implemented in phases as the NIM nodes are installed at the complexes.

V. Summary

The NIMS is designed as a modular computer utility providing tools and services which go beyond mere use of the system. Performance is met by the implementation of application programs to serve user needs. The application programs can exist independently of one another on the system or in concert with one another. Applications programmers, data base administrators, engineers, DSN management and casual users will have at their disposal the computer tools to accomplish whatever job task necessary.

Several applications have been identified for possible future implementation on the NIMS. Databases that can provide benefit to the DSN include financial management, equipment and materials management, maintenance and production control, tracking scheduling and anomaly reporting services.

Reference

1. Bryan, A. I., "A Distributed Data Base Management Capability for the Deep Space Network" *DSN Progress Report 42-33*, Jet Propulsion Laboratory, Pasadena, Calif., pp. 32-36, June 15, 1976.